THE CURIOUS CASE OF THE SANTA ROSA ISLAND PEDESTALS

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ABSTRACT

We examined a series of erosionally isolated pedestals on Santa Rosa Island that constitute natural grazing exclosures. The sites are widely separated, but occur on geologically similar marine terrace formations. Vegetation on the pedestals was markedly richer in native shrubs and other perennials and was more complex in structure than vegetation on comparable adjacent geomorphic surfaces not isolated from grazing and browsing, which were dominated by Eurasian grasses and ruderal forbs. The pedestals offered varying degrees of ungulate exclusion, possibly over different time periods. Vegetation on the pedestals was once probably representative of that seen across their respective terraces at the time they became isolated. Current differences in vegetation composition and structure on and off the pedestals apparently reflect cumulative impacts of nonnative ungulates on marine terrace vegetation since pedestal isolation. The pedestals provide some indication of the regenerative ability of native shrub species after removal or diminution of grazing and browsing. More detailed quantitative surveys of vegetation on and off the pedestals would be useful in predicting future vegetation responses to the removal of all nonnative ungulates.

Keywords: Santa Rosa Island, erosional geomorphology, ungulates, coastal sage scrub, Eurasian grasses, ruderal forbs, vegetation monitoring, vegetation change, disturbance.

INTRODUCTION

Eurasian flora and fauna were introduced to the California islands so long ago, and their impacts have been so pervasive, that it is difficult to project pre-contact vegetation cover and community composition confidently. At the same time, the proceeding or imminent removal of most or all Eurasian herbivores from many of the islands invites speculation about the changes in vegetation composition and cover that will occur with the animals' departure. Santa Rosa Island contains a set of refugia, areas from which Eurasian ungulates have been excluded, to varying degrees and for various lengths of time. We suggest that examination of these refugia and their surroundings can provide insight into both pre-contact vegetation conditions, and also the future changes in vegetation that may occur after non-native ungulate removal. There are three potential classes of refugia on Santa Rosa Island. The first is explicitly fenced enclosures and exclosures on the island. Extant exclosures date back perhaps 30 years at most, and most of the older exclosures are of limited value to projections of vegetation change for the great uplands majority of the island's area, because the earliest exclosures were established in riparian zones. The second class of refugia is aquatically isolated islets adjacent to the island. Moran (1998) examined the biota of goat-free islets of Guadalupe Island to speculate about pre-contact flora of the main island. Unfortunately, there are no equivalent islets with soil established adjacent to either Santa Rosa Island or any of the other California islands. The third class of refugia is topographically determined. At one end of a spectrum are vertical refugia (i.e., cliffs), a traditional predilection of botanists. Cliffs exclude herbivores, but their vegetation composition can be projected to other parts of the landscape only with difficulty. At the other end of the spectrum are horizontal refugia—flat or gently sloping sections of terrain isolated by catastrophic erosion surrounding them. Horizontal refugia are still problematic, as we will discuss, but we suggest that their close examination may prove quite fruitful to many issues of island vegetation dynamics.

METHODOLOGY

A reconnaissance of the island in 1997 by Cloud had disclosed a curious pedestal of gently sloping soil, entirely surrounded by profoundly eroded badlands, on a slope east of the mouth of Jolla Vieja creek on the south side of the island. The pedestal flora was visually completely distinct from that of adjacent slopes beyond the badlands, being covered with profuse perennial shrubs and sage scrub. Anecdotal accounts from other island specialists indicated there were other pedestals scattered about the island in widely separated locations, which led to the proposal to investigate the pedestal refugia in some detail. The authors and Lauren Johnson, then a botanist in Channel Islands National Park, made an initial reconnaissance of Santa Rosa Island pedestals June 21-23, 1998. We located three pedestals (Figure 1) and searched for but were unable to locate a fourth pedestal identified by Dr. Elizabeth Painter and Dr. Dieter Wilkin.

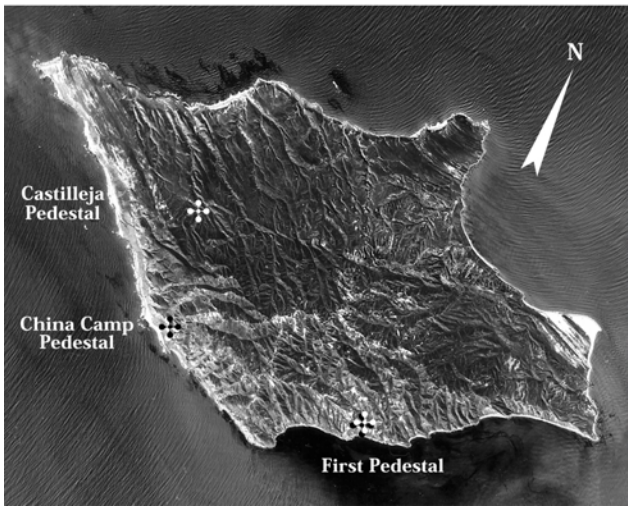

Figure 1. A now declassified Corona reconnaissance satellite photograph of Santa Rosa Island, taken March 17, 1966, with the approximate positions of First Pedestal, China Pedestal, and Castilleja Pedestal noted.

At each of the three pedestals, we determined their position by averaging GPS single-receiver geo-positions, measured the height, length, area, slope, aspect, and general context of each pedestal, and photographed the pedestals and their surroundings extensively. We conducted a census of all vascular plant species found on each pedestal, collecting voucher specimens for subsequent identification as necessary. We characterized the geological context of each pedestal by reference to the geologic map of Santa Rosa Island (Dibblee et al. 1998) in consultation with geologist Helmut Ehrenspeck.

RESULTS

Table 1 contains physical descriptions and geomorphological characteristics of the pedestals. Tables 2, 3, and 4 contain the species inventories for each pedestal, using taxonomy from Junak et al. (1995 and 1997).

We found all three pedestals to be qualitatively quite distinct in biota from adjacent non-isolated areas of similar soil type and general aspect. The pedestals were variably difficult for large mammals (including us) to access. They probably vary significantly in their histories of relative inaccessibility, although these factors are difficult to quantify.

First Pedestal is located south of and below a section of the road from Jolla Vieja east to Wreck Canyon. The pedestal is actually the largest and most vegetatively diverse of a complex of pedestaled surfaces formed by catastrophic badlands erosion of Quaternary alluvium (Qam) deposited on an island marine terrace, underlaid by South Point Sandstone formation (Tsp) (Table 1; Dibblee et al. 1998). The pedestal was covered with perennial shrubs, principally *Artemisia californica*, *Lotus dendroideus dendroideus*, and *Rhus integrifolia*, with 5 to 10 % absolute cover by the grass *Nassella pulchra*. A single large *Coreopsis gigantea* was clinging to the eroding edge of the pedestal (Table 2). In contrast, the adjacent slopes of the same alluvium beyond the isolating badlands were covered primarily by *Avena* and *Bromus* grass species.

We accessed the pedestal by traversing the upland neck of dried alluvium connecting the pedestal to higher sections of the badlands. Access is problematical during the dry season, and probably impossible for large mammals during the rainy season. We surmise that cows have been excluded from the pedestal for some time, and that deer and elk are currently excluded. The pedestal had a well-defined series of small mammal trails and bedding areas—and a severed head of a striped skunk. We observed island foxes in the immediate vicinity of the badlands.

China Camp Pedestal is actually an intermediately isolated sloping bench of Quaternary alluvium (Qam) overlaying Sespe Formation marine clastics (Ts) located between China Camp and Cluster Point on the south-west coast of the island. (Table 1; Dibblee et al. 1998). The pedestal is triangularly shaped, like a slice of pie, bounded by the convergence of two first-order deeply incised gullies that meet in a "V" at the lower tip of the pedestal. The upper end of the pedestal is bounded by cliffs mounting up the hill slope behind the pedestal. The pedestal surface is about 100 m long and perhaps 40 m wide at its widest point. The pedestal vegetation was visually distinctive at any distance due to high cover by perennial shrubs, (principally *Artemisia californica*) relative to the topographically similar slopes beyond the bounding gullies. Adjacent areas contained a larger proportion of Eurasian annual grasses and forbs, and much lower shrub cover (Table 3). An examination of cow trails on and around the pedestal indicated that large mammals were not completely excluded from access, but that access was more difficult and considerably more infrequent than on adjacent slopes. On the pedestal, annual grass cover was highest and shrub cover lowest in areas where cow pies and elk scat and trails indicated some ungulate access. In areas of high shrub cover, we saw no evidence of ungulates.

Castilleja Pedestal is the largest of another series of pedestals and grazing refugia, located on Pocket Field north of the Arlington Fault and immediately north of and below the Smith Highway on the northern slope of the island (Table 1). Castilleja Pedestal and the other refugia are older Quaternary dune and drift sands (Qos) thickly deposited on marine terraces, possibly on South Point Sandstone (Tsp) (Dibblee et al. 1998). Like the other pedestals, the vegetation is markedly richer in perennial shrubs, particularly *Artemisia californica*, but it also contained a high coverage of *Castilleja* sp. (as yet unidentified) that was visually quite apparent from a distance (Table 4). Many shrubs on the pedestal appeared mature or senescent, with many of them extending over the uppermost 2 to 3 m of the pedestal face. We found a distinct, well developed cryptogramic crust on some areas of the pedestal. There were deer and elk footprints in the bottoms of the gullies on both sides and *Heteromeles arbutifolia* with severe browse lines in the gully,

Table 1. Physical descriptions of pedestals on Santa Rosa Island.

Provisional Name	First Pedestal	China Camp Pedestal	Castilleja Pedestal
UTM (zone10S) easting	770,767	761,526	760,719
UTM (zone10S) northing	3,756,423	3,757,613	3,762,314
elevation (meters)	50	25	205
aspect	SE	SW	N
length (meters)	30	100	70
width (meters)	max 7, mean 4	max 40, mean 20	4-12
approximate area (m^2)	120	2000	500
approximate slope	20%	15-25%	25%
substrate	Quaternary alluvium (Qam) deposited on the coastal marine terrace, underlaid by South Point Sandstone formation (Tsp).	Toe of a slope of Sespe Formation marine clastics (Ts).	Older Quaternary dune and drift sands (Qos) thickly deposited on marine terraces, possibly on South Point Sandstone (Tsp).
isolating features	Gullies in erosional badlands	Two converging gullies, with a cliff on the upslope side.	Gullies in erosional badlands
recent ungulate signs?	None	Yes, cowpies, elk scat, trails at the extreme downslope end. A few cowpies in the NW corner.	None

Table 2. Plants found on First Pedestal.

Species	life form	absolute cover [a]
Artemisia californica	shrub	50%
Atriplex semibaccata	subshrub	-
Avena barbata	annual grass	-
Baccharis pilularis consanguinea	shrub	1%
Bromus hordeaceus	annual grass	-
Bromus madritensis rubens	annual grass	-
Coreopsis gigantea	shrub/ succulent	-
Gastridium ventricosum	annual grass	-
Gnaphalium bicolor	forb	-
Hazardia squarrosa v. grindelioides	shrub	-
Isocoma menziesii (v. sedoides?)	subshrub	-
Lotus dendroideus dendroideus	subshrub	15%
Nassella pulchra	perennial bunchgrass	5-10%
Opuntia littoralis littoralis	succulent	-
Pellaea andromedifolia	fern	-
Rhus integrifolia	shrub	5%
Cover by shrubs and subshrubs		80%
Total cover (including annuals)		$\geq$95%

[a] Visual estimates of absolute cover for dominant species only.

Table 3. Plants found on China Camp Pedestal.

Species	life form	absolute cover [a]
Achnatherum diegoense	perennial bunchgrass	-
Amblyopappus pusillus	forb	-
Artemisia californica	shrub	≤ 80%
Astragalus (trichopodus s. lonchus?)	subshrub	-
Atriplex semibaccata	subshrub	-
Avena barbata	annual grass	-
Baccharis pilularis consanguinea	shrub	-
Bromus diandrus	annual grass	-
Bromus hordeaceus	annual grass	-
Bromus madritensis rubens	annual grass	-
Centauria melitensis	forb	-
Daucus pusillus	forb	-
Distichlis spicata	perennial grass	-
Hordeum murinum leporinum	annual grass	-
Isomeris arborea	shrub	-
Layia platyglossa	forb	-
Lupinus succulentus	forb	-
Malacothrix saxatilis v. implicata	perennial herb	-
Malva parviflora	forb	-
Medicago polymorpha	forb	-
Melilotus indicus	forb	-
Mesembryanthemum nodiflorum	succulent	-
Nassella pulchra	perennial bunchgrass	-
Sonchus oleraceus	forb	-
Cover by shrubs and subshrubs		≤ 80%
Total cover (including annuals)		≥ 95%

[a] Visual estimates of absolute cover for dominant species only. Annual cover greatest low on slope. Shrub cover greatest midslope.

but we found no obvious evidence of browsing or scat on the pedestal. Access to the pedestal was at least as difficult at to First Pedestal and involved scrambling on all fours along the neck connecting the pedestal to the land beyond the badlands erosion.

Drs. Elizabeth Painter and Dieter Wilkin have observed a fourth pedestal (UTM zone 10S, easting 764,060, northing 3,762,400) in the western fork of Dry Canyon, but we were unable to locate it as we returned to camp at dusk.

DISCUSSION

Our examination of the Santa Rosa Island pedestals weaves together three strands of ecological investigation: speculation about broad suites of changes in xeric western American vegetation communities attendant on the introduction of Eurasian flora and fauna (Stoddart 1941; Hull and Hull 1974; Vale 1975); the possible applications of topographically isolated horizontal refugia in research on ungulates and vegetation change, including erosionally isolated mesas (Driskoll 1964) and kipukas isolated by lava flows (Tisdale et al. 1965); and the investigation of vegetation changes following ungulate removal (Harniss and West 1973).

The three pedestals we examined differed significantly in vegetation structure and species composition from adjacent areas beyond the isolating eroding gullies and badlands around them. Although the pedestals are several miles apart in three of the four major watershed segments of the island, we were initially surprised to note how geomorphologically similar the pedestals appeared. Each is a summit of thick Quaternary alluvium deposited on much more resistant marine sandstone and marine clastics, located at the toe of steeper slopes. In hindsight, these geological conditions are necessary for the formation of pedestals—if there were not steeper upland slopes to erode around them in incised gullies, ungulate access would not be restricted. Likewise, if the easily eroded marine sediment layer overlaying the resistant strata beneath were not thick, the resultant pedestals would be short, offering less impediment to animal access.

Table 4. Plants found on Castilleja Pedestal.

Species	life form
Achillea millefolium	perennial herb
Artemisia californica	shrub
Atriplex semibaccata	subshrub
Avena barbata	annual grass
Baccharis pilularis consanguinea	shrub
Bromus diandrus	annual grass
Bromus hordeaceus	annual grass
Bromus madritensis rubens	annual grass
Cardionema ramosissimum	perennial herb
Carpobrotus chilensis	succulent
Castilleja (affinis s. affinis?)	perennial herb
Centaurium davyi	forb
Cirsium sp.	forb
Daucus pusillus	forb
Gnaphalium (californicum?)	forb
Hazardia squarrosa v. grindelioides	shrub
Hemizonia fasciculata	forb
Melilotus indicus	forb
Mesembryanthemum crystallinum	succulent
Microseris sp.	forb
Polypogon monspeliensis	annual grass
Sisyrinchium bellum	perennial herb
Spergularia macrotheca macrotheca	forb
Vulpia myuros v. hirsuta	annual grass

Shrub cover variable, from 50-70% in some areas to <5% in other areas. Annual grass cover approaches 100% in between shrubs, + 30-90% overall.

This means that the processes of vegetation change we infer from the pedestals may be most applicable to other areas with similarly deep alluvial substrates on the island.

We note that the pedestals appear to have become isolated from ungulate access as a result of recent and continuing erosion. The pedestals appear to have undergone a community composition shift from the Eurasian annual grasses still predominant on surrounding soils beyond the isolating badlands, to predominantly sage scrub and perennial shrubs. We propose that this is re-establishment of sage scrub on the pedestals, rather than preservation of remnants of some earlier pristine community. It is clear that the pedestal surfaces were once easily accessible gentle slopes that were subsequently isolated by episodes of catastrophic erosion. We cannot determine how long the isolating processes took. It is likely, however, that the gullies isolating the pedestals started after intensive grazing began on the island in the 1850s, which correlates with massive deposition of eroded sediments on the island lowlands beginning about that time (Cole and Liu 1994). We surmise that the soil surfaces comprising the pedestals were once undifferentiated from their surroundings. Hence the future pedestal surfaces were once probably impacted by grazing in a manner similar to the surrounding areas. Therefore their current vegetation composition represents change from previously more disturbed conditions. Although we did not discover any truly rare species on the pedestals (every botanist's dream on that denuded island) neither did we encounter any explosions of invasive exotic species. We note further that all these pedestals are located within one hundred meters of island roads, suggesting that investigations further afield may reveal more pedestals.

The pedestals of Santa Rosa Island are a unique and temporary resource. It is possible that the principal era of recent erosion on the island was initiated by sheep and occurred during their era (Woolley 1998), but we saw abundant evidence that the pedestals are still eroding rapidly. Erosional processes triggered or accelerated by ungulates can continue even after the animals have been removed (Trimble and Mendel 1995). As sheep, pigs, and now cows have been removed from the island, and the removal of horses, elk, and deer is imminent, we propose establishing permanent vegetation transects across each of the pedestals, including sections of adjacent lands along the transect lines beyond their isolating badlands. Lauren Johnson has already established a point intercept transect at midslope on China Camp Pedestal. Interpreting the pedestals' histories is difficult, but it is quite possible that the pedestals represent the longest time series of ungulate exclosures on nearly flat terrain in existence on Santa Rosa Island.

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